Biotreatment of Municipal Solid Waste in Aerobic and Anaerobic Laboratory Bioreactors

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Research Questions

As the requirements for stabilization and containment become increasingly stringent operating landfills as bioreactors is becoming more economically feasible. To compare the use of aerobic and anaerobic management strategies three 200-liter tanks filled with fresh waste materials were used to provide the following conditions: (a) aerobic (air injection with leachate recirculation), (b) anaerobic (leachate recirculation), and (c) a dry-tomb anaerobic landfill (no air injection, no water addition and no leachate recirculation). The tanks were monitored for metals leaching, nutrients, organic carbon, subsidence, gas composition, respiration rates, and microbiological activity for up to 500 days.

Results

Leachate from the aerobic tank had significantly lower concentrations of all potential contaminants, both organic and metal, after only a few weeks of operation. Respiration tests on the aerobic tank showed a steady decrease in oxygen consumption rates from 1.3 mol/day at 20 days to 0.1 mol/day at 300 days (see Figure 1). Over the test period, the aerobic tank settled 35%, the anaerobic tank 21.7% and the dry-tomb tank 7.5% (see Figure 2). The aerobic tank produced negligible odor compared to the anaerobic tanks. Metals leaching were low throughout the test period for the aerobic tanks, and decreased over time for the anaerobic tanks. Microbiological testing showed high biomass and diversity in both the aerobic and anaerobic bioreactors, high activity in the anoxic leachate, but low activity in the aerobic leachate.

Conclusions

This study demonstrated that maintaining the MSW landfill as an aerobic bioreactor increased the rates of settling and stabilization and produced more environmentally benign leachate and gas. The aerobic landfill bioreactors showed significantly more settling than the anaerobic reactor and maintained a neutral pH and low levels of all measured parameters (nitrate, phosphate, BOD, COD, and metals) compared to the wet, anaerobic bioreactor leachate. The reduction in noxious odors was a significant advantage of the aerobic system. These results suggest that aerobic management of MSW landfills could increase the rate of stabilization, produce less potent greenhouse gases, eliminate the need for leachate and air emissions treatment systems, reduce odor, and reduce the need for extensive containment strategies.

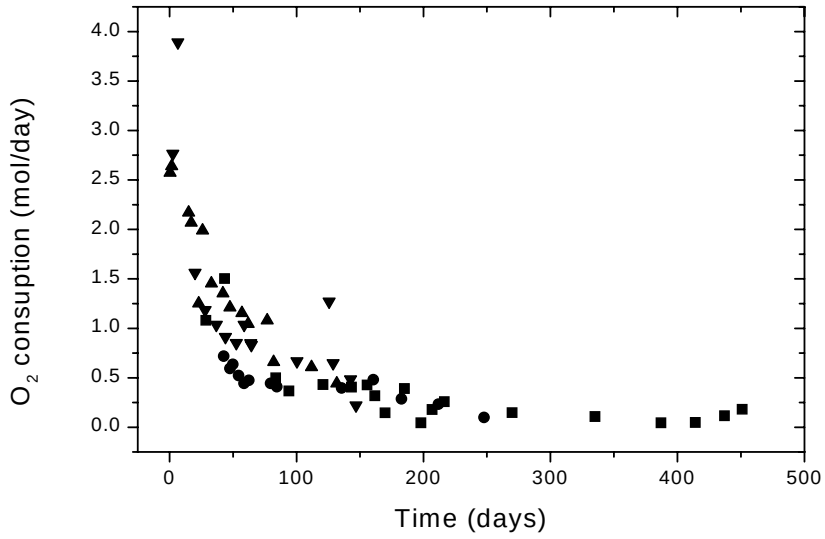

FIGURE 1. Oxygen consumption rate showing decline during aging of the MSW in the aerobic tanks.

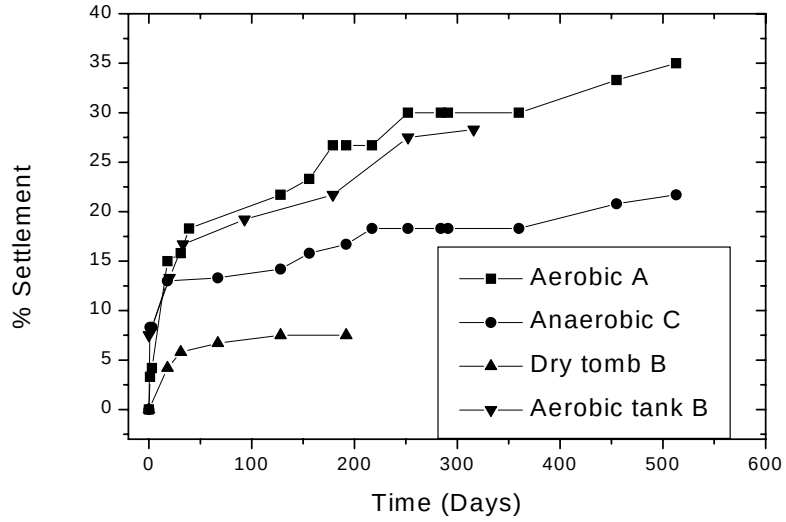

FIGURE 2. Cumulative settlement of the MSW from 0 to 500 days. The start time of the aerobic tank B has been corrected by 197 days for the period of time it was managed as a dry tomb.